

COACHES

COoperative Autonomous Robots in Complex and Human Environments

Coordinator : Abdel-Ilhah Mouaddib

Partners : University of Caen Basse-Normandie, France

University of Sapienza Roma, Italy

Vrije Universiteit Brussel , Belgium

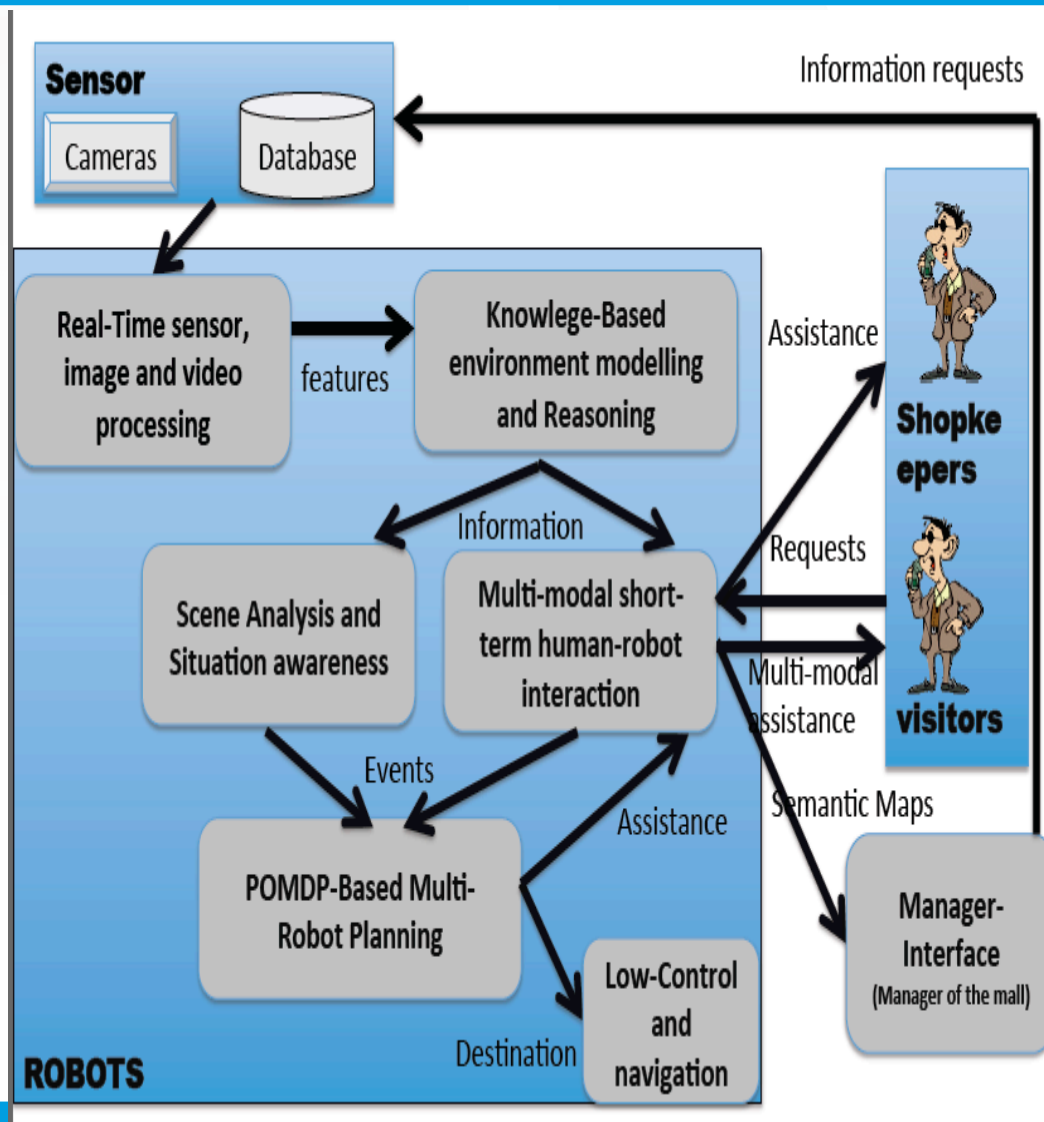
Sabancı University , Istanbul, Turkey

Participants: Agglomeration Caen la mer, Ville de Caen
Rive de L'orne Mall, Caen
SME Algorithmica, Italie



Motivation

- Deploying robots in public areas to assist, guide, and escort visitors and surveillance
- Visual applications are born:
 - Guidance and Personal assistance in public areas
 - **Shop malls, touristic sites, airport, train stations, hospitals**
 - Surveillance and patrolling in cooperative way with intervention units (**firefighters, police, medical units, and tourist office staff, ...**)
- **Our target use cases:**
 - **Caen Rive de l'Orne Shopping Mall in cooperation with Caen city**



- **Environment modelling and Knowledge-based reasoning**
 - Commonsense and semantic knowledge-based reasoning
 - Nonmonotonic and spatio-temporal reasoning
- **Image and Video processing**
 - Fusing external and onboard cameras
 - Tracking people in crowded environments
 - Detecting abnormal objects
- **Multi-modal short-term human-robot interaction**
 - From robot to people: GUI, and text-to-speech processing
 - From people to robot: GUI, speech understanding
- **Multi-Robot cooperative planning and Robuste Navigation**
 - Robust and safe Navigation in populated areas
 - Goal-Based Interaction Decentralized Decision-Making for Multi-agent Planning

- **Increasing the autonomy of multi-robot systems evolving in populated environments**
 - Distributed perception and collective situation awareness
 - Distributed and coordinated planning
 - Smooth and short interaction with people
- **Increasing the robustness of robot navigation in populated environments**

- **GREYC-CNRS/France**
 - Intelligent and autonomous systems
 - Distributed planning and decision-making
 - Probabilistic reasoning
 - Vision
- **Sapienza/Italy**
 - Robotics
 - Multi-robot systems
 - HRI
- **Vrije University (VUB)/Belgium**
 - Image&Video processing
 - Speech understanding
- **Sabanci University (SU) /Turkey**
 - Cognitive systems
 - Knowledge-based reasoning
- **GREYC**
 - Pr. A.I. Mouaddib, multi-robot planning and AI
 - Dr. L. Jenapierre, AI and Robotics
 - F. Ferrari, PhD, joint activity and escort
 - R. Negrel, post-doc, Vision
- **Sapienza**
 - Pr Luca Iocchi, Multi-robot, HRI
 - Pr D. Nardi, Robotics
 - Post-doc, Mayte T. Lazaro: HRI and Navigation
- **VUB**
 - Pr Hichem Sahli, Video and image processing
 - Post-doc, A. Pennisi, Vision
- **SUB**
 - Dr E. Erdem, nonmonotonic reasoning, KBS
 - Dr A. Volkan, nonmonotonic reasoning, KBS

WP1: Environment modelling and Knowledge-based reasoning (SU)

- T11: Knowledge-based environment representation
- T12: Commonsense and spatio-temporal reasoning

WP2: Image and Video processing (VUB)

- T21: Image and video processing (VUB)
- T22: Situation awareness, activity recognition and abnormal events (GREYC)

WP3: Multi-modal short-term HRI (Sapienza)

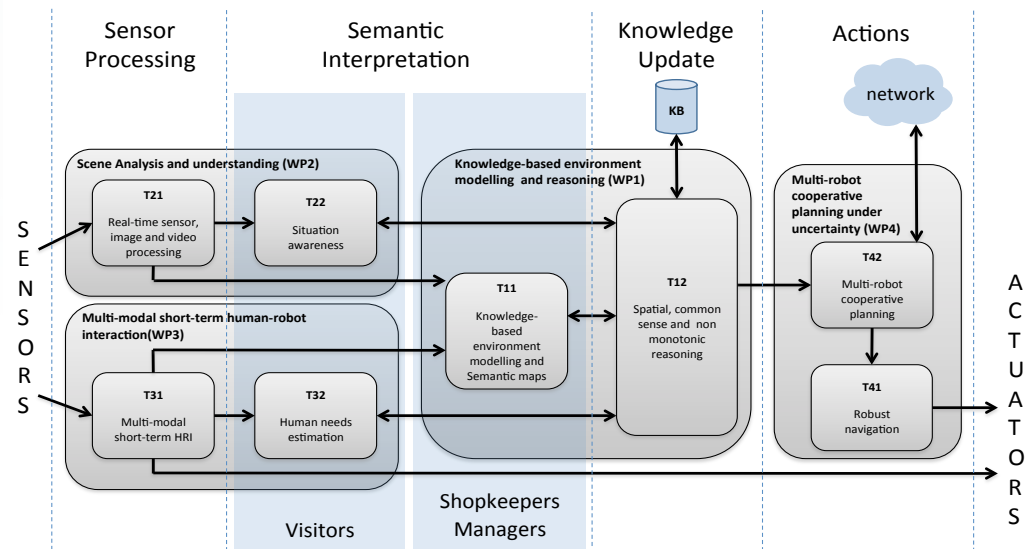
- T31: multi-modal human-robot interface From robot to human and From human to robot (Sapienza)
- T32: Human needs estimation (GREYC)

WP4: Multi-Robot cooperative planning and Robuste Navigation (GREYC)

- T41: Robust and safe Navigation (Sapienza)
- T42: Goal-Based Interaction Decentralized Decision-Making for Multi-agent Planning (GREYC)

WP5: Soft and hard architecture, use cases and integration/validation (GREYC)

- T51: ROS-based Architecture, (Sapienza and GREYC)
- T52: Use cases definition (GREYC)
- T53: Setup of the robots, (Sapienza)
- T54: Demonstrations, (all)
- T55: Performance evaluation (all)



Main scientific Result



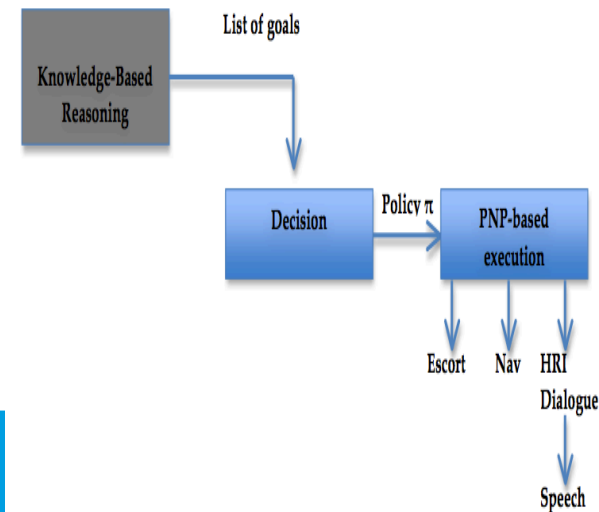
- **T11: Knowledge-based representation**
 - First version with Semantic and static (SEM) and Commonsense (COM) Knowledge using prolog-like predicate program (M12, **GREYC-SU**)
 - New version with temporary (TEMP) under development by **SU (Due by M18)**
- **T12: Commonsense and spatial reasoning**
 - (due by M21)

- **Knowledge**
is-a(fastFood,restaurant).
instance-of(mango, womenDressShop).
nearby(mango, desigual).

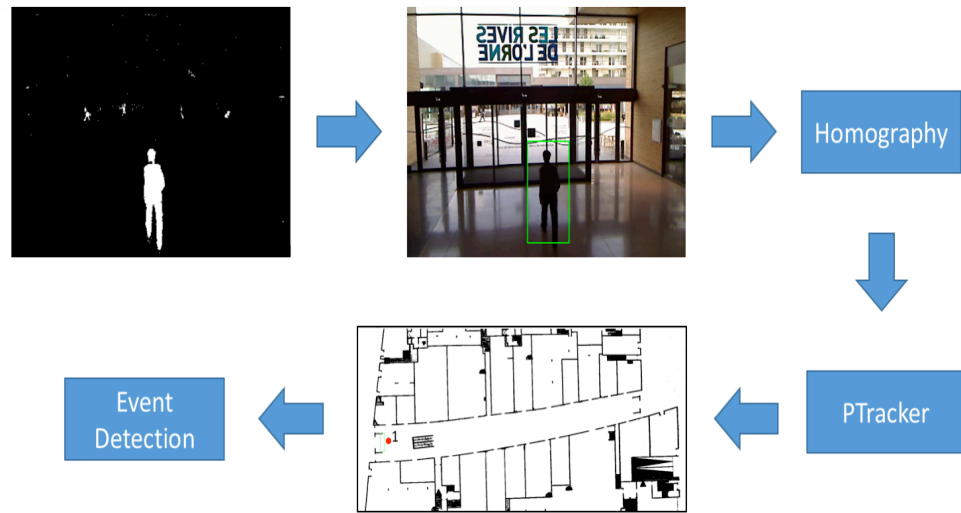
- **Goal rules**
goal('secure', L) :-
unknownObject(X),
at(X, L).

goal('advertise', L) :-
people(X),
at(X, L),
ad(L).

goal('assist', L) :-
people(X),
at(X, L).



- **T21: image/video processing**
 - First result: detecting people and tracking (M12, VUB) from external camera using FAFEX, HOG and Ptracking
 - Final version due by M18
- **T22: Event detection**
 - Detection of people inside specific area.
 - Extension to other events (due by M21)



- T31: Multi-modal human-robot Interaction

(due by M27, first version M12 Sapienza)

- From human to robot:
 - Tactile screen, microphone
- From robot to human
 - Screen, text-to-speech
- Coming : speech understanding

- T32: Human needs estimation
(due by M27, GREYC, first version M15)



- **T41: Robust Navigation** (First version M9, Final version by M24, Sapienza)
- **T42: Multi-robot planning**
 - First version, a single robot(M9, Final version by M24, GREYC)

WP2:
Perception



Extracted features

WP1
KB reasoning



List of goals

WP4
MDP-based planning



Computed policy π

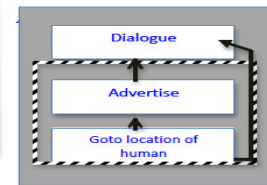
Petri-Net execution plan



Navigation



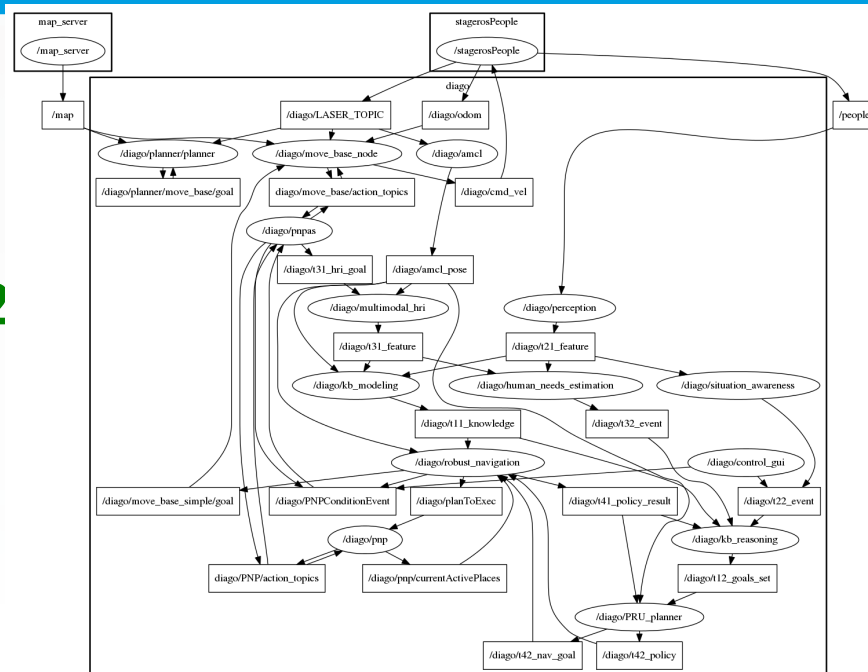
Selected PRU



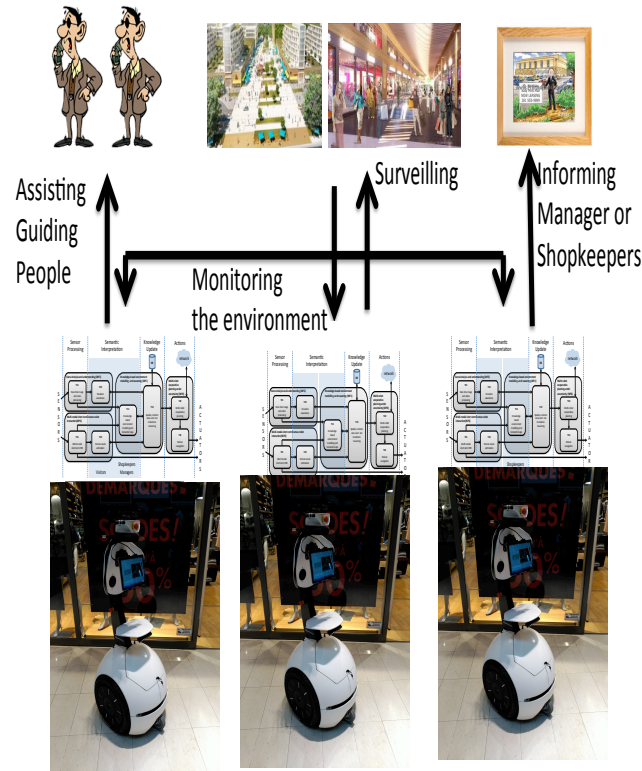
Assistant



- **T51: ROS Architecture M3(Sapienza, GREYC)**
- **T52: Definition of use cases M12 (GREYC)**
 - 1. Robot advertising and simple interactions, 2. Extending to multiple robots; 3. Complex dialogue and escort, 4. General demo
- **T53: Setup of the robots M14 (Sapienza)**
- **T54: First demo on February 8th 2016, M15 (All)**
- **T55: under development**



- Robust navigation in crowded environments
- Monitoring the environments
- Interacting with people
- Accomplishing tasks : assistance, escort and support security units



SERVICES

SOFTWARE

ROBOTS

- The COACHES software
- Decision module is based on a series of transformations of PRU in MDP and an MDP in a PNP.
- The software of PRU-MDP-PNP transformation is available in :
 - <https://sites.google.com/a/dis.uniroma1.it/petri-net-plans/pnp-generation>